Transportation Synthesis Report

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U.S. and Overseas Conversion to LEDs in Traffic Signals
Operational and Cost/Benefit Experience

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Transportation Synthesis Reports (TSRs) are brief summaries of currently available information on topics of interest to WisDOT technical staff in highway development, construction and operations. Online and print sources include NCHRP and other TRB programs, AASHTO, the research and practices of other state DOTs, and related academic and industry research.

REQUEST FOR REPORT

WisDOT has begun replacing incandescent bulbs in traffic signals with energy-conserving, light-emitting diodes (LEDs). The RD&T Program was asked to investigate the experience of other states with LEDs. This report is organized in terms of (1) Extent of state system traffic signals converted to LEDs, (2) Cost-benefit analysis, and (3) Experience of state DOTs.

SUMMARY

Extent. A search of transportation Web sites, searchable databases, academic research sites, and newspaper databases shows that, while many states and municipalities have run trials of LED traffic signal conversions from incandescent bulbs, only California has completed a state-wide conversion of highway and freeway traffic signals. In addition to California's full conversion, Washington has converted all but yellow globe signals in a five-county area from south of Seattle up to the Canadian border, and Florida has converted all red globe signals in the state system.

Cost-benefit. In lieu of formal cost-benefit analyses, many agencies have calculated financial benefits of conversion. The Rensselaer Polytechnic Institute found that experiences around the world match those in California, Washington and Florida. Eighty percent of municipalities reviewed in England, New Zealand, Australia and the U.S. documented energy savings, and 90 percent documented maintenance savings. By 2000, New York's partial conversion of about 2,100 intersections was saving 17 million kilowatt hours, or $1.5 million.

Experience. The three states report typical maintenance schedules that require replacement of LEDs in five- to ten-year periods, compared to one year for incandescents; signal failure is reported at ten percent the rate, or less, of incandescents; sunlight-induced "phantom light" experiences have been eliminated by LED designs. LEDs reduce the need for emergency personnel to man darkened intersections in blackouts by permitting low-cost, long-lasting back-up battery systems.

CALIFORNIA

Extent. The California DOT (Caltrans) has been working with LEDs since it began a five-year test program in 1993. Conversion of all state DOT system lights is 90 to 95 percent complete, with full conversion expected in the next few months. During the test period, many state municipalities converted to LED signals after reviewing data from the ongoing state project.

Cost-benefit. Caltrans measures its savings in terms of kilowatt hours to accommodate rising electricity rates. Energy savings typically match the 85 percent reduced draw predicted. A full highway and on-ramp intersection that formerly ran on 2,900 watts runs on 500 with LEDs. The payback period is two-and-a-half years. The cost of LED lamps continues to drop; red 12-inch lamps that cost $180 five years ago cost less than $50 today. Back-up battery systems cost $3,000 per intersection to install, compared to $10,000 for incandescent systems.

Experience. According to Gomez, LED lights fail at about 10 percent the frequency of incandescent bulbs. Increased reliability reduces exposure of Caltrans maintenance crews to traffic, reduces strain on power grids, and changes re-lamping schedules from once per year to once every five years for red LEDs, and once every ten years for green and yellow. Back-up battery LED systems can operate at full power for four hours, compared to 30 minutes for incandescent systems.

Information: Gonzalo Gomez, Caltrans' helpful maintenance chief, maintains data on maintenance and use costs, 916-654-2461, ggomez@dot.ca.gov. Jim Rhodes, Caltrans Research Lab, 916-227-7040, james.rhodes@dot.ca.gov. See also http://www.dot.ca.gov/hq/esc/ttsb/electrical/lighting.htm.

WASHINGTON

Extent. The state of Washington replaced red and green globe signals, and red, green and yellow arrows with LEDs in five heavily populated counties, including King County, site of the Seattle metropolitan area. Replacements were completed in 2001.

Cost-benefit. During the 2001 West Coast energy crisis, electricity rates rose 60 percent in 2001, but Seattle-area DOT bills rose only 35 percent due to conversion. The higher rates reduced the payback period to less than two years. Furthermore, the cost of about half the installed bulbs was reimbursed by a local utility company at the rate of $96 each.

Experience. Reliability, durability and driver comments favor LEDs. The bulb replacement schedule has expanded from one year to six. Lamp failures have virtually ceased. Signal fixtures show no change in fatigue following LED bulb installation.

Information: Northwest Region Signals Superintendent's Office, 206-764-4250; Bryan Bailey, Assist. Supt., can offer data on number of units installed, and savings and driver comments in King County, baileyb@wsdot.wa.gov.

FLORIDA

Extent. The Florida DOT converted all its state system red lights to LEDs by the beginning of 2001. Green lights and yellow are under review, with recommendations expected shortly.

Cost-benefit. Individual counties and municipalities, not the state, track real savings. The system, however, used 135-watt incandescents; LEDs drop required wattage to as little as 7 for arrows, and 10 for other LED bulbs. The Miami Herald reported on Dec. 1, 2001, that conversions of 1,325 intersections to red and green LEDs in Miami and Broward County were to save $1 million per year, enjoy a payback period of three years, after which the county would save $900,000 per year over the life of the LEDs.

Experience. Too early to say. The state research lab is still testing green LEDs. It has not yet gathered data on the anticipated energy and maintenance savings.

Information: State research lab's Carl Morse, 850-414-4863 or State research lab's Carl Morse, an engineer with extensive knowledge of the testing of individual units and projected benefits, 850-414-4863 or carl.morse@dot.state.fl.us. The state works closely with Florida State University in Tallahassee on LED traffic signal studies. See http://rite.eng.fsu.edu/led/.

MUNICIPALITIES AND OTHER STATES

California Municipalities. Two 1998 surveys of California cities found many using LEDs. In a Caltrans survey, 48 percent of polled municipal organizations had installed LED traffic signals, saving an average of 40 percent in energy costs. See http://www.energy.ca.gov/efficiency/partnership/LEDSURVEY.PDF. The Lighting Research

Center at the Rensselaer Polytechnic Institute in Troy, NY, surveyed 31 cities in California, finding that 74 percent use LED lights. See http://www.lrc.rpi.edu/ltgtrans/led/index.html. Note, the Rensselaer site also offers external links to case studies in over 50 municipalities and states.

International Study. The multi-year Rensselaer study for the New York DOT mentioned in the summary, above, reviewed LED conversions in cities in the U.S., England, Europe and New Zealand. Surveys were conducted in 2000, with some follow-up in 2002. See http://www.lrc.rpi.edu/ltgtrans/nysled/. For more, contact John Bullough, adjunct assistant professor, bulloj@rpi.edu or 518-687-7100.

City Links and Contacts. The majority of municipalities here enjoy loans or reimbursements from local energy providers, and all report significant energy savings.
Allentown, PA – Don Steele, a self-identified LED enthusiast and city traffic engineer, 610-437-7735
Anaheim, CA, a 1999 report – http://www.anaheim.net/utilities/news/sig_ret.html
Iowa City, IA – Jeff Davidson, comm. planning, jeff_davidson@iowa-city.org or 319-356-5252
Northern VA – http://www.virginiadot.org/infoservice/news/NOVA04082002-bulbs.asp